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a complete disappearance of this substance been shown by the experiments, conclusive proof would then have been afforded of the primary nature of the aldehyde.

H. M. R.

Light and the Respiration of Fungi.¹—By a series of carefully arranged experiments, chiefly with *Aspergillus glaucus* and *Penicillium*, it is shown that the action of light increases (*circa* 10 per cent) the respiration of these fungi, and that this increase is independent of the food supply and of the morphological condition of the culture. As the author says, this increase, though not great, is quite contrary to what our knowledge of these forms would lead us to expect. He refrains from drawing any conclusions from the present data, evidently purposing to pursue the matter further. The results recorded are noteworthy and, if supported by further ones, are of considerable importance.

H. M. R.

Spore Development in the Hemiascæ.²—Two forms of this heterogeneous group are considered in detail as to their spore development. These are Ascoidea and Protomyces. In the former it appears that the spores when ripe lie in a mass of protoplasm analogous to the condition generally found among the Ascomycetes, but the multinucleate condition of the ascus and the behavior of these contained nuclei do not seem to correspond to the observations recorded in the late researches on this last-named group. In Protomyces, on the other hand, the spores do not lie imbedded in a mass of unused protoplasm, but are free within the remnant of the protoplasmic sac which still adheres to the wall of the sporangium. This condition the author regards as more nearly akin to that found in the Phycomycetes. The result of the observations seems to show that these two members of the Hemiasci, aside from their radical dissimilarity in other ways, are not closely related in the matter of spore formation. This it will be noticed does not agree with the arrangement of these forms adopted by Brefeld, but to the average observer who has seen Protomyces, points of similarity of that form with the phycomycetous fungi are not surprising.

H. M. R.

A New Work on Lichens.—Lieferung 180 of *Die natürlichen Pflanzenfamilien* forms the first portion of Fünfstück's account of the

¹ Kolbswitz, R. Ueber den Einfluss des Lichtes auf die Athmung der niederen Pilze, *Prings. Jahrb.*, Bd. xxxiii, Heft 1, p. 123, 1898.

² Canna, M. L. Popta. Beiträge zur Kenntniss der Hemiasci, *Flora*, Bd. lxxxvi, Heft 1, p. 1, 1899.

Lichenes. From this a few general statements are culled which may be of interest to non-lichenologists. The literature of lichens is very extensive, that here cited covering three closely printed pages. With very few exceptions lichens are of slow growth and long life, several decades being required by some alpine sorts to reach maturity and fructification. The greater number occur on rocks, but many are found on tree trunks, dead wood, or on the earth. Only a few sorts grow under water (*Verrucaria* sp.). It may be assumed that nearly every one knows that lichens are symbiotic growths. It is now just thirty years since the publication of Schwendener's memorable paper, and the matter was fought over and settled in the seventies. In different lichens the relation between the fungus and the alga is very different. In *Physma*, *Arnoldia*, and many other genera the algal cells are destroyed by the fungus, haustoria being sent through the algal membrane into the plasma. In other lichens, such as *Micarea*, *Synalissa*, the haustoria bore through the algal membrane but do not penetrate into the plasma. As a rule the algal cell is entered by only one haustorium. Finally, in many lichens, *e.g.*, those with *Protococcus* gonidia, the relation of the two components is only one of intimate contact, the fungus causing no visible change either in the membrane or in the contents of the algal cells. The manner of union of fungus and alga is very constant in any given species of lichen, and it is usually the fungus which determines the form of the lichen. According to external form, lichens may be classified as bushy, leafy, or crustaceous. Formerly much use was made of these distinctions for purposes of classification, but this system has now been abandoned, as separating closely related forms. Classification is now based largely on the ascospores. For anchorage and food absorption lichens are united to the substratum to very different degrees. The most intimate union is that of crustaceous, calcivorous species — *Verrucaria*, *Staurothele*, *Thelidium*, etc. The hyphæ of some of these species penetrate into the stony substratum in all directions, to a depth of ten to twenty millimeters or more. On the other hand, the *Collema*s, etc., only rest their gelatinous masses on the substratum without producing any visible change in it. Between these extremes are various intermediates. Even the hardest rocks are eroded by lichens. *Lecanora polytropa* offers a striking example of this, the hard gneiss rock to which it adheres being eroded into cavities exactly the size and shape of the lichen crusts which occupy them. In most lichens the algal elements are confined to a particular zone, but in some sorts the algæ are

uniformly distributed through the body of the thallus. This difference has little systematic value. With few exceptions, some of which are still disputed, the lichen fungi all belong to the Ascomycetes. The lichen algæ belong to the Schizophyceæ and Chlorophyceæ. Rarely filamentous forms occur. The various lichen fungi have not been found growing free except in case of a few Basidiolichenes, and some saprophyte Ascomycetes which occasionally form so-called "Half-lichens"; but in a number of cases they have been cultivated free. Many, if not all of the lichen algæ, are also believed to occur free in damp places, but owing to changes in shape and size, brought about by the presence of the fungus, there is still much uncertainty respecting the identity of the algal element in the thallus of many lichens. Quite a number of these algæ have been cultivated independently of the fungus, and ten species found in lichen thalli have been definitely identified as well-known species occurring independently of fungi. These belong to as many different genera. Almost always each species of lichen is adapted to one species of alga, but sometimes accessory species of algæ are present in the thallus, forming in connection with the lichen-fungus growths called cephalodia. The fungus provides the imprisoned alga with water and inorganic foods. It loses nothing itself by this symbiosis and gains the ability to live on bare rocks and other most resistant surfaces. What benefit the algæ derive from such unions is problematic. In the lichen thallus they are said to reach a larger size and to divide more rapidly than outside; they are also able to live and work in places otherwise unsuitable. On the other hand, they have very generally lost the ability to produce swarm spores, a function soon regained on cultivating them free from the fungus. The lichen attacks the rocks by means of acid excretions which the fungus alone appears to be unable to produce. More than sixty acids have been isolated and described, and the chemistry of the group is complex. The reproduction of the group, aside from mere vegetative propagation by soredia, which is very common, is that of the fungus. Oidial, or chlamydospore, fructification has been found only in Caliceæ. Free conidial fructification, so common in the Ascomycetes, has been found only in two lichens. Pycnidia, on the other hand, are common. The highest form of fructification is by means of ascospores. In some lichens this form is wanting, or at least has never been found. Basidiospores are said to occur in the tropical genera *Cora* and *Corella*. According to the author it is exceedingly probable that even in *Collema* there is no sexual reproduction. Lichens are often

brilliantly colored, browns, grays, and yellows preponderating. They are very rich in variety of forms, but these seldom resemble the separate growths of either component. Nearly 20,000 species, varieties or forms of lichens, have been described, but only about 4000 are well known. Lichenes are distributed over the whole earth. They occur farthest north and farthest south, and highest up on mountains of any plants. They are resistant to heat and to cold. Hot countries are relatively poor in species. In the Torrid zone they are found mostly on trees. The outer fungus rind is thin in the shade and thick in the sun. In hot, dry countries all the lichens have a common habit (Australia, Cape of Good Hope, Chili). Cold countries, especially in the northern hemisphere, are richest in species. Many species are widely distributed. Very few are edible. Among the latter, perhaps the most interesting is the rapidly growing manna lichen, known to the Tartars as earth bread, and a variety of which (*Lecanora esculenta* var. *jussufii*), easily blown about by the wind, and then known as "rain manna," is perhaps the manna of the Israelites.

ERWIN F. SMITH.

Agardh's Algæ.¹ — It is not often that an author, fifty years after the issue of the first part of a work, is, like Professor Agardh, still continuing its publication. Nor does this fifty years by any means cover the time during which the name of Agardh has been among the foremost in algological science. The elder Agardh, father of the present author, was already publishing his observations quite early in the present century, and in 1823 he issued the first volume of his *Species Algarum*, intending to include in the work all the species known at the time. It remained unfinished, but it marks a distinct advance in systematic algology.

Its author had the valuable faculty, in arranging a genus or group of higher rank, of seeing clearly the really distinctive characters and using them as a basis of classification. This faculty appears in even a higher degree in his son, J. G. Agardh, and for many years his *Species Algarum*, of which the first volume was published in 1848, has been the standard, especially as to the red algæ. It is only within the last three or four years that an arrangement of the red algæ, differing seriously from Agardh's, has been presented and has met with any general acceptance. The arrangement of Schmitz, as given by Engler and Prantl, is based on the details of the fertilization

¹ Agardh, J. G. *Species, Genera, et Ordines Algarum*, voluminis tertii, pars tertia. De dispositione Delesseriearum curae posteriores. Lund, 1898.